

## LIGHTNING IN THE PROTOPLANETARY NEBULA?

Lightning in the protoplanetary nebula has been proposed as a mechanism for creating meteoritic chondrules: enigmatic mm-sized silicate spheres formed in the nebula by the brief melting of cold precursors. Reports of lightning in volcanic plumes and dust storms (with diverse particle properties) and in outer planet atmospheres (with compositions similar to the nebula) support the idea of nebular lightning. Conversely, the high conductivity, low ( $\sim 10^{-5}$  bar) gas pressure, and limited turbulent energy of the nebula may have prevented or weakened lightning there. Despite much work, there is still no consensus on whether lightning could have occurred in the nebula and, if so, whether it could have melted chondrules.

Better understanding of lightning in the protoplanetary disk requires better knowledge of the nebular environment: particle sizes, compositions, and charges; gas pressure, composition, temperature and conductivity; and turbulent speeds and length scales. Improved communication between astrophysics, space physics, and atmospheric sciences might help constrain these parameters; better theoretical understanding of terrestrial lightning would assist in relating them to lightning in the nebula.

Further work on nebular lightning might investigate local gas density enhancements (such as planetesimal atmospheres), dimensional scaling relationships linking chondrules to fulgurates, the detailed behavior of nebular radionuclides and the free charge thereby generated, and possible nebular analogs of red sprites and blue jets.